**FULL TITLE PAGE**

**Full title:** Testing factors associated with acceptability of risk-stratified breast screening: individual characteristics and order effects of risk and benefit information

**Short title:** Acceptability of reduced-frequency risk-stratified breast screening

**Manuscript type:** Short report

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**ABSTRACT**

*Objectives:* We tested whether reduced-frequency risk-stratified breast screening would be perceived more favourably by transposing the order of information on benefits and risks.

*Methods:* 698 women completed an online survey after reading vignettes describing non-stratified 3-yearly screening and a risk-stratified alternative with 5-yearly invitations for women at low-risk. Participants were allocated at random to information on screening benefits followed by risks, or vice versa, and asked to state preferences for either screening system. Participants also rated perceived magnitude of screening benefits and risks, and breast cancer susceptibility.

*Results:* Binomial logistic regression did not find order effects on preferences (p=.533) or perceived benefits of screening (p=.780). Perceived screening risks were greater when risks were presented first (p<.0005). Greater perceived susceptibility was associated with lower proportions preferring risk-stratified screening (15% vs. 39% in highest and lowest groups; p=.002), as were greater perceived screening benefits (e.g. 13% vs. 45% in highest and lowest groups; p<.0005).

*Conclusions:* No information order effect on preferences was observed; information order did affect screening risk perceptions. Efforts to improve perceptions may need to be more intensive than those tested. Women perceiving themselves as high-risk or perceiving greater benefits of screening may be particularly averse to less frequent screening.

*Keywords:* Acceptability; risk-stratified screening; cancer screening; breast screening

## INTRODUCTION

Risk-stratified breast screening has been mooted for improving existing programmes by determining individuals' risk status (e.g. based on genetic factors) and tailoring screening interventions accordingly (e.g.[1]). For example, women at low-risk could be screened less intensively, minimising opportunity costs and harms due to test inconvenience and overdiagnosis. Research on its acceptability to the target population is necessary in order to ensure high levels of uptake[2] and existing studies show that prospective screening invitees may have preconceptions that more intensive screening is superior to less intensive screening. In particular, women are relatively accepting of those at high-risk being invited for mammography more frequently than the current triennial default in England but less willing to accept longer intervals for those at lower risk.[3]

A potentially important determinant of perceived acceptability of screening programmes is the written information that invitees are given prior to their participation (e.g.[4]). This often aims to give invitees knowledge about screening benefits and risks, allowing them to make an informed choice about their participation.[5] In organised programmes, this generally represents the main or only way that invitees learn about screening. It is considered necessary that this information is sufficiently accurate and suitable for purpose, meaning that the ethics of changing it are complex.[6,7] However, there may be valid opportunities to increase perceived acceptability of reduced-frequency risk-stratified breast screening using subtle methods of designing information that still respect these requirements.

Previous research has found evidence that preferences and perceptions can be influenced using a wide range of psychological methods, and in diverse healthcare contexts and clinical groups.[8] For example, authors of screening information materials necessarily decide whether to summarise benefits of screening before risks or vice versa[6] and these different orders may have psychological effects.[8] A relevant study exploring information order effects in the context of genetic testing for breast cancer risk found that participants had more positive attitudes and intentions (but greater risk perceptions and fewer disadvantages) when advantages were presented before disadvantages.[9] We hypothesised that similar order effects (so-called "primacy" and "recency" effects) may also affect the acceptability of longer screening intervals for women at low-risk. For example, if women are more inclined to have genetic testing for breast cancer when advantages are presented first, this order may

result in a larger proportion favouring risk-stratified breast screening, in which genetic testing is part of the process.

A pilot study provided some evidence for the efficacy of this manipulation: In a survey sample of 205 participants, 36% stated a preference for risk-stratified screening with longer intervals when allocated at random to read information on screening benefits before those of risks vs. only 19% with this preference who read screening risks first ($X(1)=7.25$; $p=.007$).

We conducted a larger experimental survey as a confirmatory test of this order effect. Secondary aims were to test i) whether information order affected perceptions of screening risks and benefits and ii) associations between preferences and other factors (e.g. perceived susceptibility to breast cancer).

**METHODS**

Approximately 700 women aged 40-70 years and not previously diagnosed with breast cancer were recruited to an online survey (Appendix 1) from the panel of a survey company.[a] Participants read a vignette outlining the current Breast Screening Programme in England and a risk-stratified alternative: breast screening every three years for women at average genetic risk of breast cancer and every five years for women at low genetic risk (no specific information was provided on a screening strategy for women at high genetic risk). To test for an order effect, the vignette ended with information on screening benefits followed by information on screening risks or vice versa (i.e. two groups, in which the order was determined at random). In order to minimise cognitive load for participants and maintain their attention, information on screening risks and benefits was kept brief and did not provide quantitative estimates of their magnitude. Participants were asked their preference for either *"breast cancer screening offered every 3 years to all women aged 50 to 70 years"* or *"breast cancer screening offered every 3 years to women aged 50 to 70 years if they are at average genetic risk and breast cancer screening offered every 5 years to women aged 50 to 70 years if they are at low genetic risk"*.

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[a] Three additional manipulations were assessed in pilot surveys of approximately 200 participants each to establish which (if any) were most likely to be effective. These manipulations were i) an "endowment", reminding participants that they, personally, would be invited for screening vs. no reminder, ii) explicit information about the current triennial screening interval vs. no information on the current interval, iii) social norm information on the proportion of women who take up an invitation to the Breast Screening Programme in England vs. no information (results not shown). However, the provisional effect size estimate was largest for the information order manipulation and hence this was selected to be tested in a larger sample where a more precise estimate could be generated.

After reading the information, participants were asked a multiple choice question testing their comprehension of part of it (the proportion of breast cancers diagnosed in women aged over 50 years). If they did not respond to this correctly, they were asked the question again (with the option to return to the previous page) until they gave the correct answer, after which they were asked the next question in the survey. Perceived benefits and risks of screening were assessed using a scale with response options from 0-100, denoting how positively (for benefits) or negatively (for risks) participants rated these. We hypothesised that if preferences were related to the order of risk and benefit information, the magnitude of perceived risks and benefits would also differ between manipulations. The main analysis used binomial logistic regression to test whether women's stated preferences for status quo screening was associated with the experimental manipulation, after controlling for covariates (e.g. perceived susceptibility to breast cancer, perceived benefits and risks [as quintiles], and age). Perceived benefits and risks of screening were compared between the two levels of the experimental manipulation using Mann-Whitney U tests.

Institutional ethical approval was obtained (reference: 2951/005).

**RESULTS**

698 of 733 eligible participants completed the survey with analysable data.[b] Mean age was 53.4 years (standard deviation: 7.9). 285 (41%) were aged 40 to 46 years (i.e. currently ineligible for breast cancer screening) and 97% spoke English as a first language. A majority stated a preference for status quo screening in both benefits-first and risks-first manipulations (78% vs. 74%; 76% overall). Results of binomial logistic regression (n=587) did not show an effect of the experimental manipulation on preferences although three covariates were associated: Those rating themselves at higher perceived susceptibility to breast cancer, who answered the comprehension question incorrectly on the first attempt, and with higher scores of perceived benefits were more likely to prefer status quo screening (Table 1).

Mann-Whitney U Tests for differences between experimental conditions in perceived screening benefits found only weak evidence against the null hypothesis when analysing i) all participants

[b] 5 participants who provided inconsistent data on the comprehension question were excluded.

(medians and interquartile ranges: 93.0, 20 vs. 92.0, 21 for benefits-first vs. risks-first; U=60,036, z=-.280, p=.780) and ii) only participants who answered the comprehension question correctly on the first attempt (94.0, 20 vs. 93.0, 19; U=34,921, z=.018, p=.986). However, there was strong evidence against the null hypothesis for comparisons of perceived screening risks. Median scores were lower for participants who read benefits-first vs. risks-first among all participants (12.0, 28 vs. 22.0, 40, U=72,043, z=4.25, p<.0005) and in the sensitivity analysis (12.0, 26 vs. 20.0, 39; U=40354, z=3.12, p=.002).

Table 1 – Results of the binomial logistic regression model testing variables associated with preferences for either status quo or risk-stratified screening

| | | Stated preferences: % (n) | | Preferred status quo (vs. risk-stratified screening) | |
|---|---|---|---|---|---|
| **Characteristic** | **Total (n=587)** | **Risk-stratified (25.4%; n=149)** | **Status quo (74.6%; n=438)** | **Adjusted odds ratio, 95% confidence interval** | **p** |
| **Information order** | | | | | |
| Benefits-first | 278 | 24.5 (68) | 75.5 (210) | 1.26, 0.83 to 1.91 | .272 |
| vs. Risks-first | 309 | 26.2 (81) | 73.8 (228) | | |
| **Comprehension** | | | | | |
| First response correct | 437 | 27.2 (119) | 72.8 (318) | 0.53, 0.32 to 0.88 | **.014** |
| vs. First response incorrect | 150 | 20.0 (30) | 80.0 (120) | | |
| **Education** | | | | | Overall: .459 |
| Graduate level and above | 137 | 28.5 (39) | 71.5 (98) | 1.17, 0.47 to 2.91 | .735 |
| A-/AS-levels and equivalents | 48 | 33.3 (16) | 66.7 (32) | 0.84, 0.30 to 2.36 | .740 |
| GCSEs and equivalents | 158 | 17.7 (28) | 82.3 (130) | 1.66, 0.66 to 4.14 | .280 |
| Trade apprenticeships or other | 208 | 26.9 (56) | 73.1 (152) | 1.11, 0.47 to 2.65 | .814 |
| vs. No formal qualifications | 36 | 27.8 (10) | 72.2 (26) | | |
| **Perceived susceptibility to breast cancer** | | | | | Overall: **.003** |
| Much higher | 34 | 14.7 (5) | 85.3 (29) | 3.56, 1.05 to 12.11 | **.042** |
| A little higher | 86 | 20.9 (18) | 79.1 (68) | 2.85, 1.18 to 6.90 | **.021** |
| About the same | 357 | 23.0 (82) | 77.0 (275) | 2.68, 1.27 to 5.61 | **.009** |
| A little lower | 71 | 40.8 (29) | 59.2 (42) | 1.07, 0.45 to 2.53 | .879 |
| vs. Much lower | 39 | 38.5 (15) | 61.5 (24) | | |
| **Perceived benefits of screening** | | | | | Overall: **<.0005** |
| 100 | 159 | 13.2 (21) | 86.8 (138) | 6.51, 3.17 to 13.34 | **<.0005** |
| 96.00 to 99.99 | 96 | 25.0 (24) | 75.0 (72) | 3.16, 1.54 to 6.51 | **.002** |
| 89.00 to 95.99 | 105 | 17.1 (18) | 82.9 (87) | 5.97, 2.89 to 12.37 | **<.0005** |
| 74.00 to 88.99 | 120 | 31.7 (38) | 68.3 (82) | 2.29, 1.25 to 4.20 | **.007** |
| vs. 0 to 73.99 | 107 | 44.9 (48) | 55.1 (59) | | |
| **Perceived risks of screening** | | | | | Overall: .092 |
| 48.00 to 100 | 115 | 23.5 (27) | 76.5 (88) | 1.40, 0.62 to 3.18 | .422 |
| 24.00 to 47.99 | 118 | 31.4 (37) | 68.6 (81) | 0.90, 0.41 to 1.96 | .794 |
| 10.00 to 23.99 | 130 | 30.8 (40) | 69.2 (90) | 0.59, 0.28 to 1.24 | .165 |
| 1.00 to 9.99 | 124 | 23.4 (29) | 76.6 (95) | 0.64, 0.31 to 1.32 | .222 |
| vs. 0 to 0.99 | 100 | 16.0 (16) | 84.0 (84) | | |
| | | **M (SD)** | | | |
| **Age (in years)** | 587 | 53.5 (8.1) | 53.3 (7.8) | 1.00, 0.97 to 1.02 | .690 |

## DISCUSSION

This study did not find an effect of information order on preferences. However, there were several key findings of relevance to future implementation of risk-stratified breast screening. First, we found an order effect for perceived risks of screening, with risks rated lower when presented after benefits. This supports the current design of the NHS breast screening leaflet[4] which summarises risks and benefits in this order.

Second, a notable majority of this large sample of women (76%) stated a preference for status quo screening over risk-stratified screening. Although the sample was not selected to be fully representative of the general population, these results reinforce similar findings from previous studies[3,10-11] and hence suggest that transitioning to risk-stratified breast screening would be met with resistance if some women are invited less frequently. A recent quantitative survey found evidence that this applies internationally: only 57% of women surveyed in five European countries stated that they would consider less cancer screening if they were at lower than average genetic risk.[12] This is also consistent with recent qualitative research from Australia, highlighting that women feel a strong emotional connection to current methods of breast screening.[13]

A relevant caveat to this finding is that a greater number of screening risks were presented compared with benefits. This is consistent with the existing NHS screening information leaflet,[4] but may have increased preferences for reduced-frequency (i.e. risk-minimising) breast screening, in accordance with a processing difficulty effect.[14] However, participants' ratings for the one benefit stated (saving lives from breast cancer) were clustered near the maximum allowed by the scale, whereas ratings of perceived screening risks were distributed more widely, suggesting that the nature of risks and benefits was more important than the number.

Third, perceived benefits of screening were positively associated with favouring status quo screening, consistent with this being a key determinant of preferences. Fourth, greater perceived susceptibility to breast cancer was associated with preferences for status quo screening. This finding may explain results of previous studies such as those showing that women who have previously experienced a (false) positive screening result may be more resistant to reduced screening[15] (i.e. they may perceive themselves to be more susceptible). These findings are also broadly consistent with the PROCAS (Predicting Risk of Breast Cancer Screening) project, where the overwhelming majority of women informed they were at high-risk of breast cancer took up their next mammography invitation (99%).[1] However, an appreciable proportion of women continue to overestimate their risk after feedback[16] and may require specific reassurance if they are offered less frequent screening.

Finally, null findings for the manipulation tested suggest that preferences for status quo screening may not be easily changed using subtle information modifications. However, a limitation of this study was that after excluding three alternatives that were ineffective in piloting, only one manipulation was tested; other manipulations may have had more success. For example, there is some evidence that simple manipulations such as loss-framing (e.g. *"not going for screening means you miss an opportunity to avoid dying from breast cancer"*) increases perceptions of screening effectiveness vs. gain-framing (e.g. *"going for screening means you have an opportunity to avoid dying from breast cancer"*)[17] and that personalised risk feedback increases knowledge of screening and may increase uptake.[18] Further relevant psychological heuristics and biases are described elsewhere.[8]

A further limitation was that information was not part of a full screening invitation; responses may have differed if additional information had been provided, outside a hypothetical context. In

particular, we assumed participants would infer the rationale for why screening intervals might be longer for women at low genetic risk than those at average genetic risk (i.e. because screening invitations were stated to be based on risk) but this was not stated explicitly and may have reduced the perceived acceptability of risk-stratified screening. In addition, the information referred to the possibility of overdiagnosis but not the corollary risk of overtreatment; this may have resulted in participants rating screening risks less negatively and increased the proportion stating a preference for status quo screening. However, previous research has found that participants' preferences around risk-stratified breast screening are relatively unaffected by even detailed information on overdiagnosis and overtreatment so this may not have affected the results substantially.[13] We also did not provide quantitative estimates of the magnitude of screening risks (e.g. chances of overdiagnosis) or benefits (i.e. chances of preventing breast cancer death) since the primary aim of the study was to test for the presence of an effect of information order on preferences and not to estimate population perceptions of acceptability, specifically. This may have affected participants' evaluation of risks and benefits. However, a trial assessing knowledge of overdiagnosis in breast cancer screening reported far higher mean scores for knowledge of the concept than associated statistics, suggesting invitees focus less on numerical information.[19] Finally, we did not assess preferences for other forms of risk-stratified screening e.g. more frequent screening for women at higher risk. This could be tested in future studies.

In conclusion, we found little evidence that preferences for risk-stratified screening could be increased by amending the order of risk and benefit information; efforts to increase perceived acceptability may need to be more intensive. However, perceived risks of screening were lower when information about screening risks was read after screening benefits. We also found that preferences were associated with perceived screening benefits and susceptibility to breast

cancer, meaning that women at low objective risk but high perceived susceptibility may be particularly concerned if offered less frequent screening.

**Contributors:** AG, JW, STS, IV, and CVW conceived and designed the study. AG analysed the data. AG, JW, STS, IV, and CVW participated in the interpretation of results. AG, JW, STS, IV, and CVW drafted the manuscript, participated in critical revision, and approved the final version.

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**Competing interests:** None declared.

**Participant consent:** Obtained.

**Supplementary materials:** No additional materials are available.

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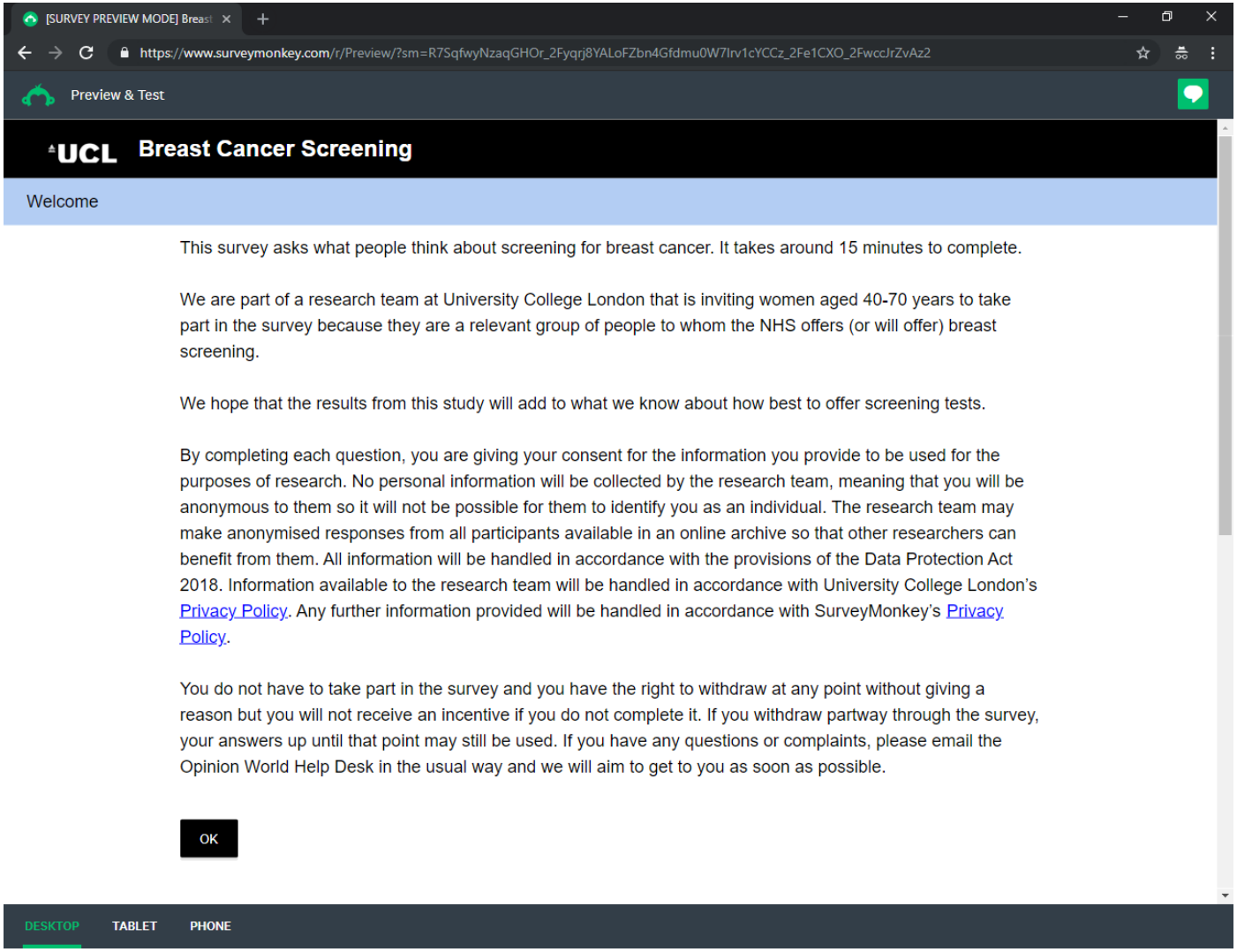
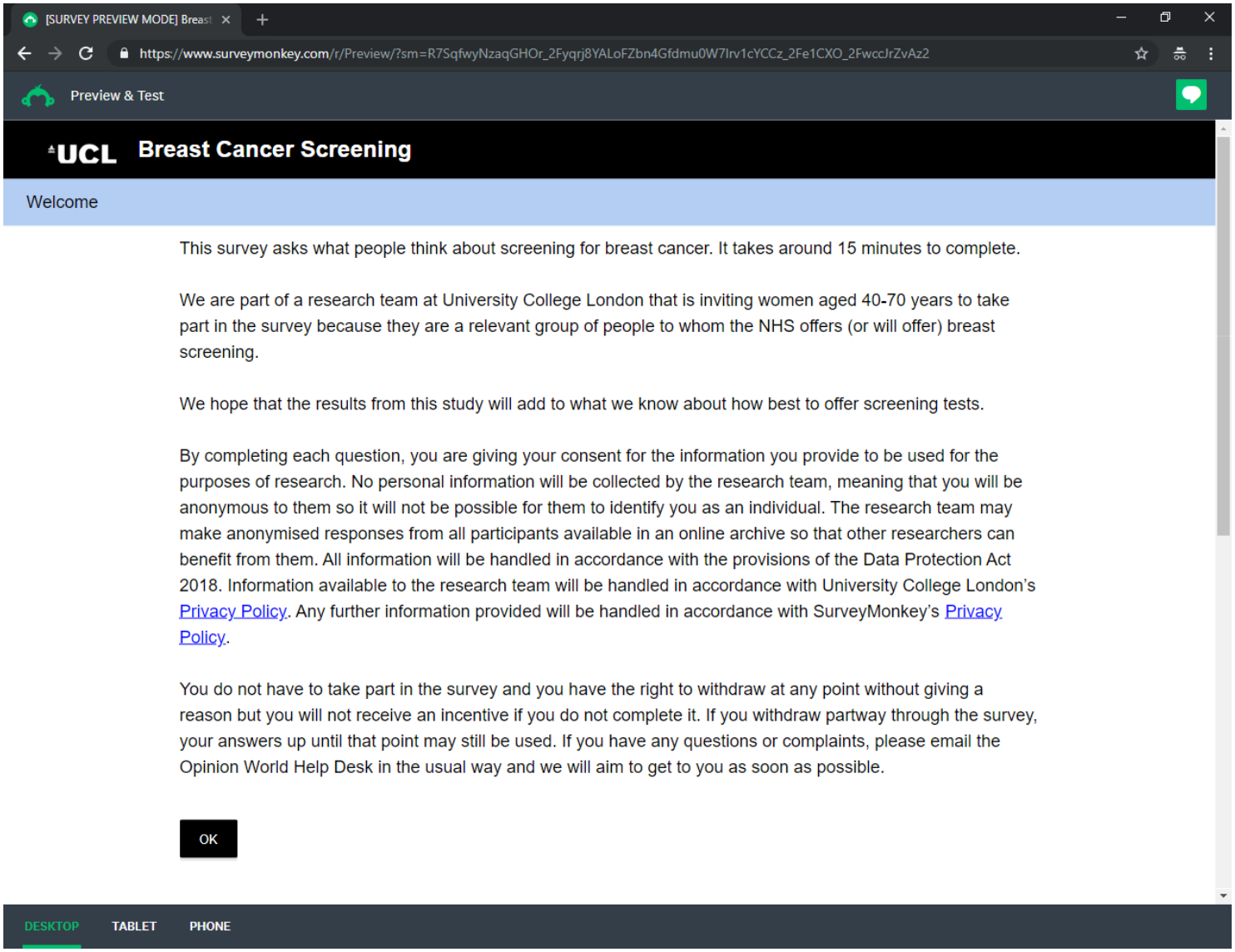
## APPENDIX 1 – SURVEY

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Preview & Test
UCL
Breast Cancer Screening
Welcome
This survey asks what people think about screening for breast cancer. It takes around 15 minutes to complete.
We are part of a research team at University College London that is inviting women aged 40-70 years to take part in the survey because they are a relevant group of people to whom the NHS offers (or will offer) breast screening.
We hope that the results from this study will add to what we know about how best to offer screening tests.
By completing each question, you are giving your consent for the information you provide to be used for the purposes of research. No personal information will be collected by the research team, meaning that you will be anonymous to them so it will not be possible for them to identify you as an individual. The research team may make anonymised responses from all participants available in an online archive so that other researchers can benefit from them. All information will be handled in accordance with the provisions of the Data Protection Act 2018. Information available to the research team will be handled in accordance with University College London's Privacy Policy. Any further information provided will be handled in accordance with SurveyMonkey's Privacy Policy.
You do not have to take part in the survey and you have the right to withdraw at any point without giving a reason but you will not receive an incentive if you do not complete it. If you withdraw partway through the survey, your answers up until that point may still be used. If you have any questions or complaints, please email the Opinion World Help Desk in the usual way and we will aim to get to you as soon as possible.
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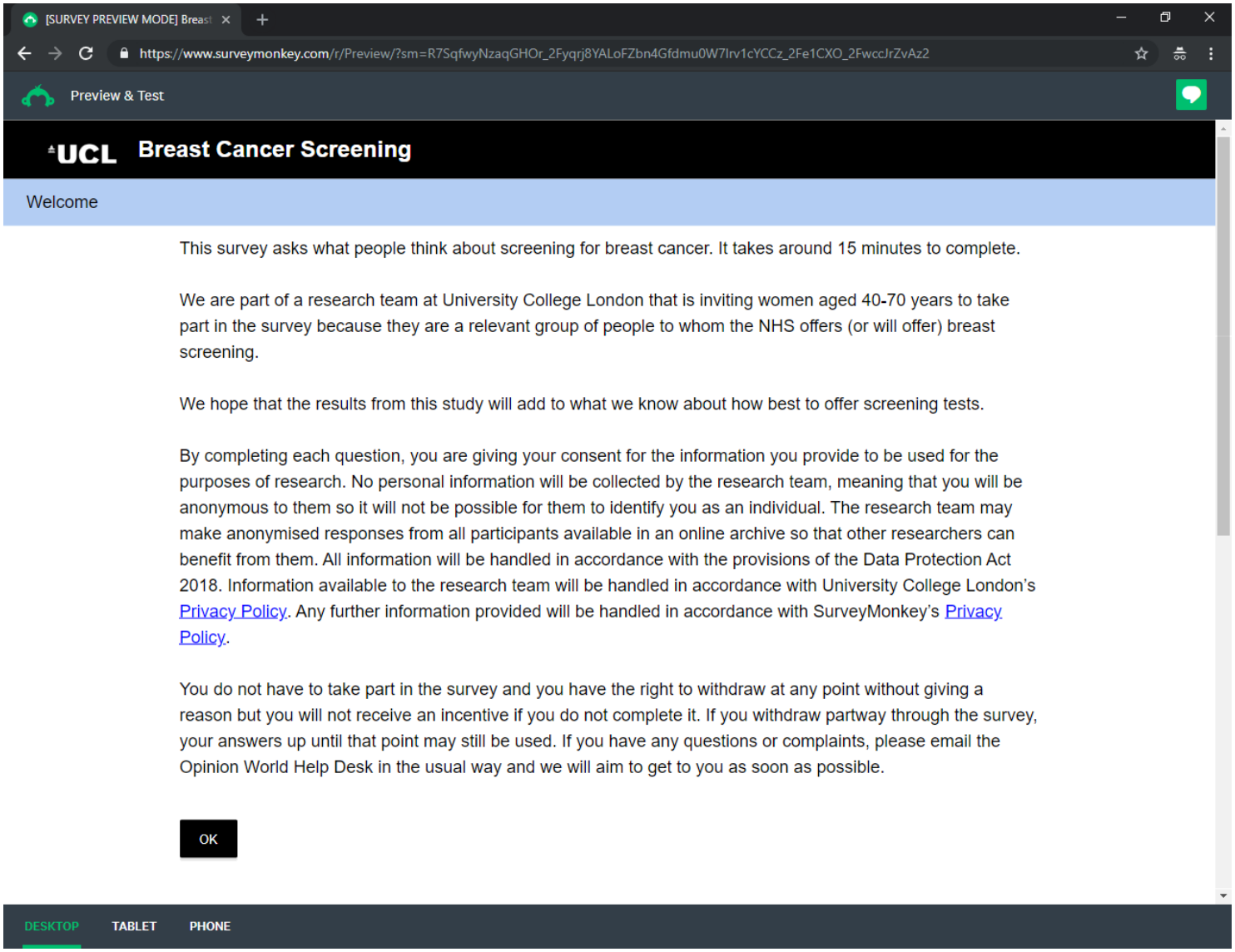
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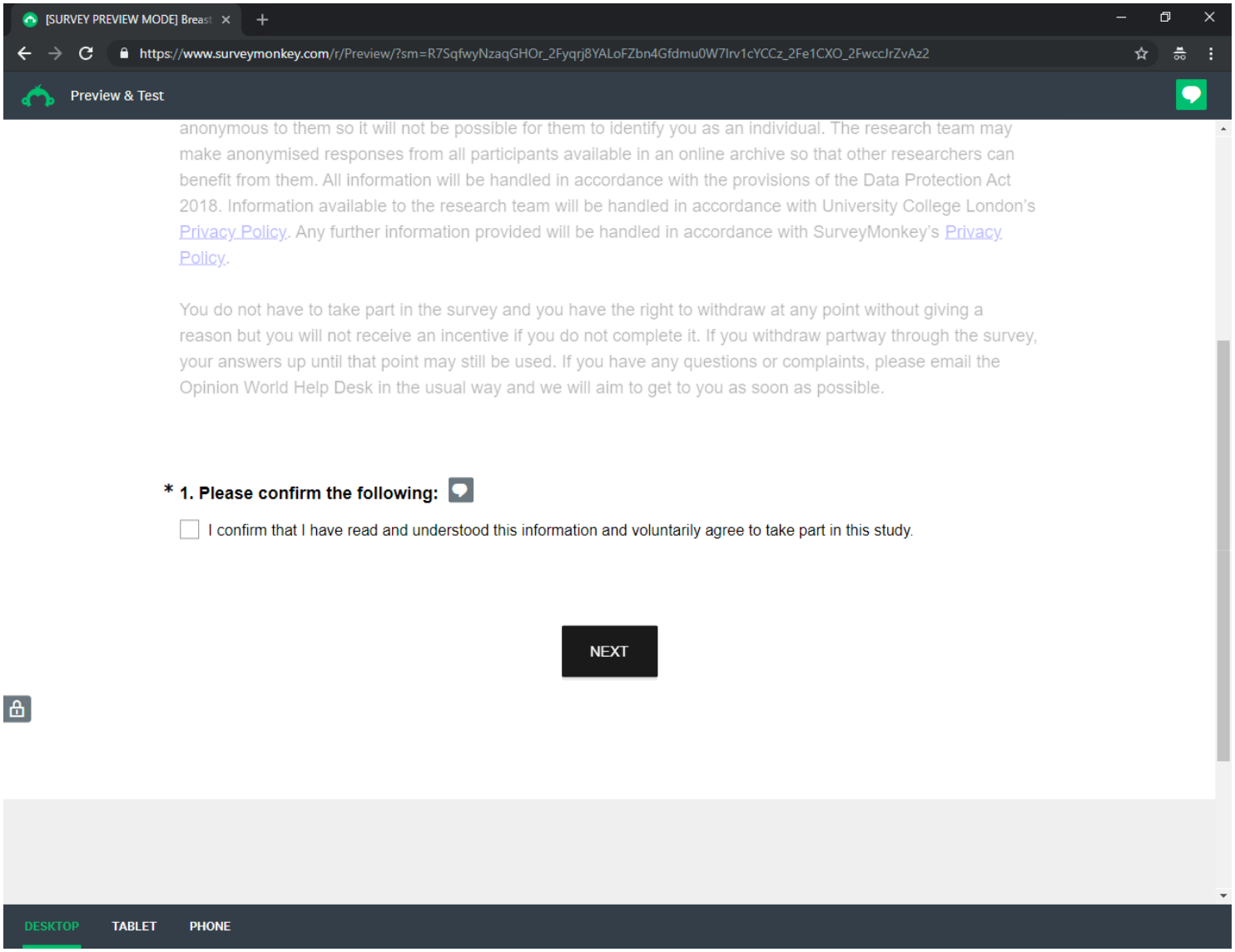
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anonymous to them so it will not be possible for them to identify you as an individual. The research team may make anonymised responses from all participants available in an online archive so that other researchers can benefit from them. All information will be handled in accordance with the provisions of the Data Protection Act 2018. Information available to the research team will be handled in accordance with University College London's Privacy Policy. Any further information provided will be handled in accordance with SurveyMonkey's Privacy Policy.
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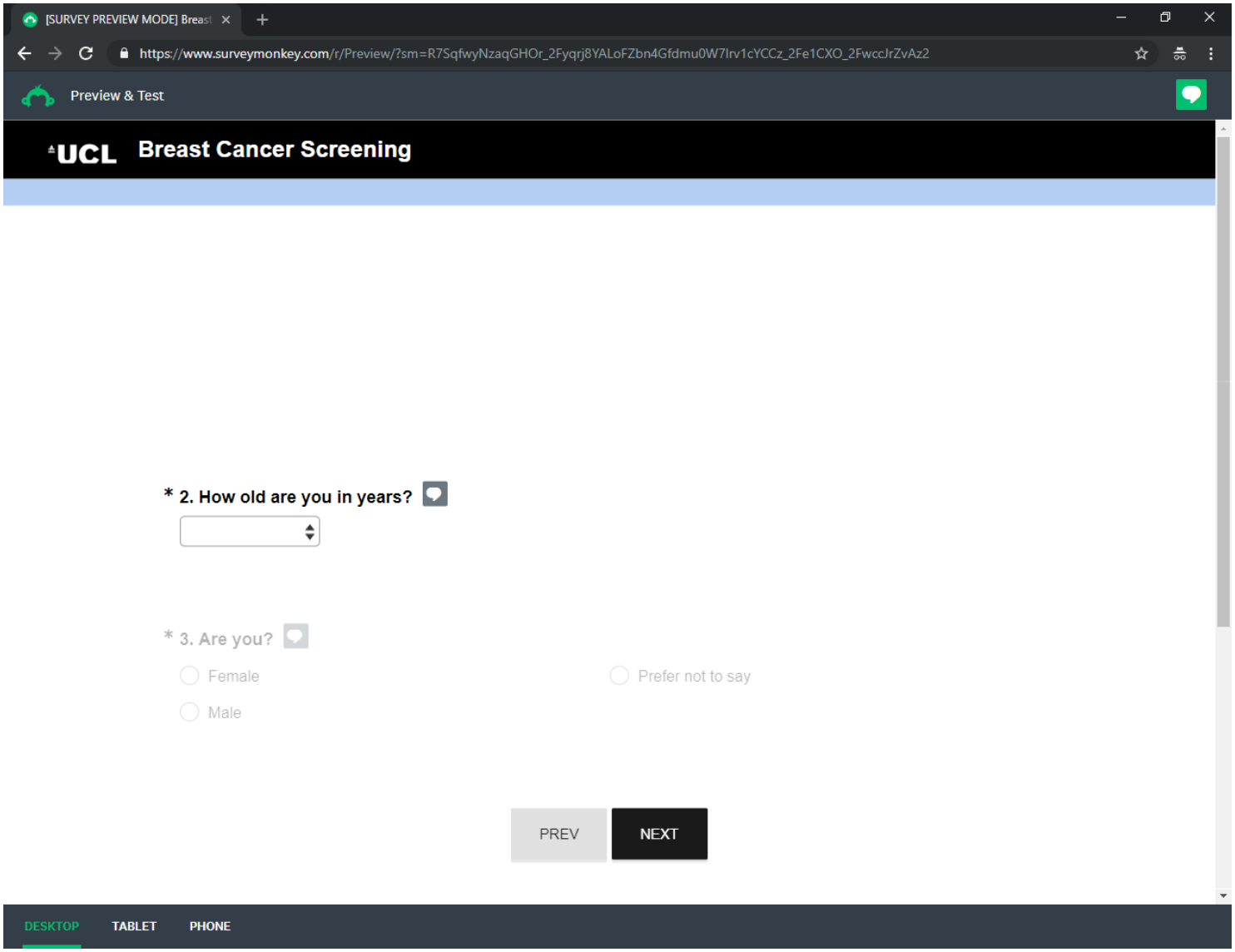
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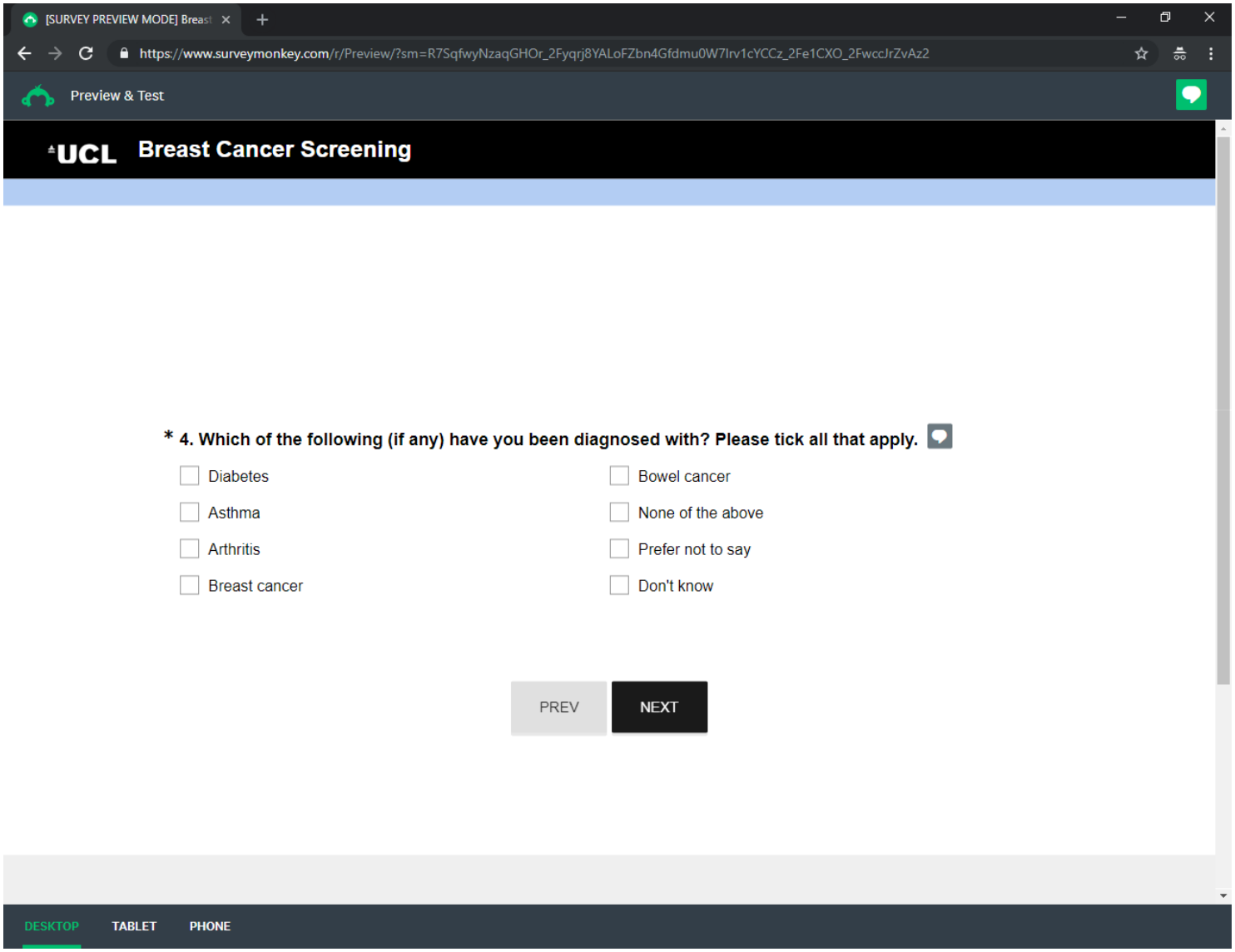
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Preview & Test
UCL Breast Cancer Screening
* 4. Which of the following (if any) have you been diagnosed with? Please tick all that apply.
Diabetes
Asthma
Arthritis
Breast cancer
Bowel cancer
None of the above
Prefer not to say
Don't know
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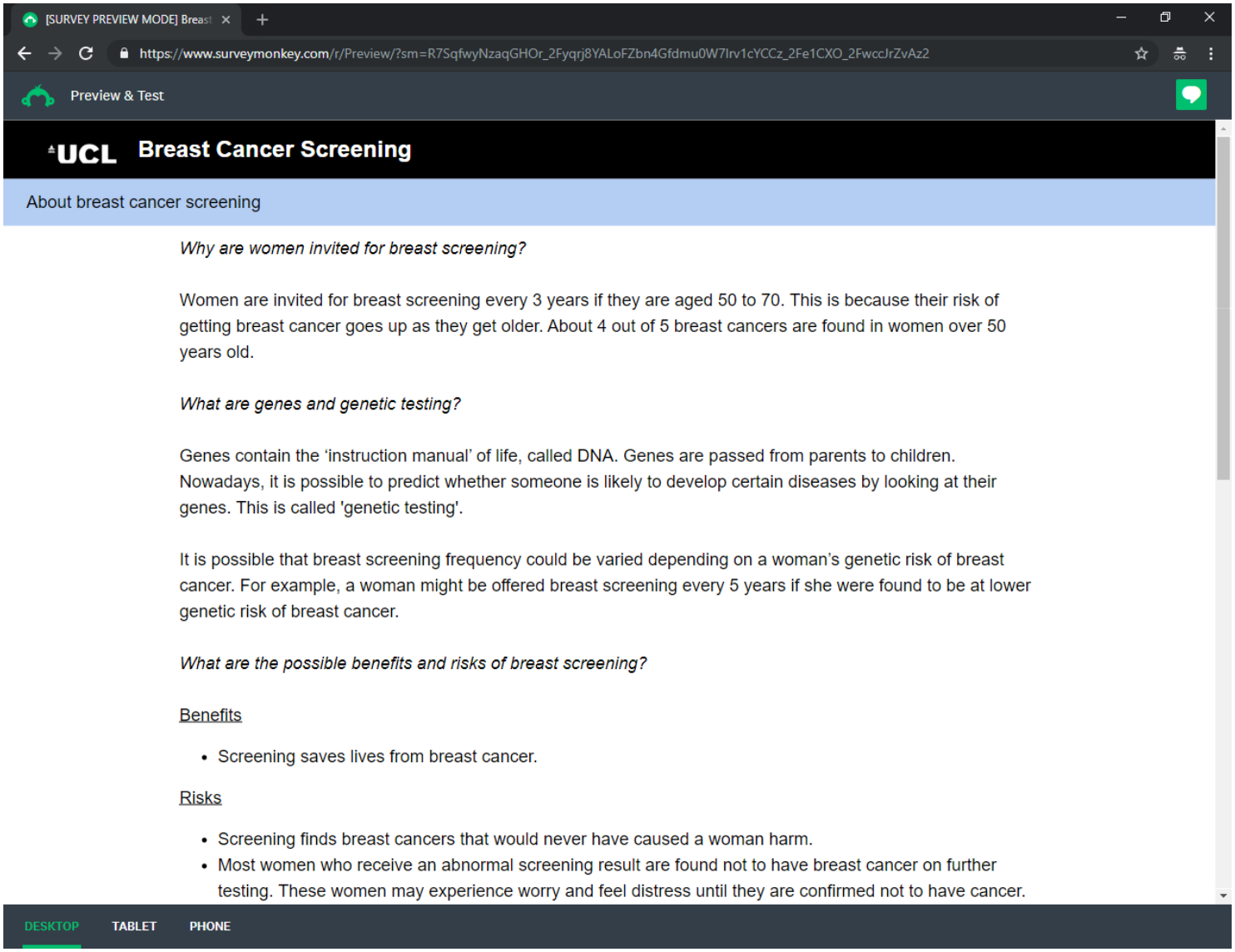
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Preview & Test
UCL Breast Cancer Screening
About breast cancer screening
Why are women invited for breast screening?
Women are invited for breast screening every 3 years if they are aged 50 to 70. This is because their risk of getting breast cancer goes up as they get older. About 4 out of 5 breast cancers are found in women over 50 years old.
What are genes and genetic testing?
Genes contain the 'instruction manual' of life, called DNA. Genes are passed from parents to children. Nowadays, it is possible to predict whether someone is likely to develop certain diseases by looking at their genes. This is called 'genetic testing'.
It is possible that breast screening frequency could be varied depending on a woman's genetic risk of breast cancer. For example, a woman might be offered breast screening every 5 years if she were found to be at lower genetic risk of breast cancer.
What are the possible benefits and risks of breast screening?
Benefits
Screening saves lives from breast cancer.
Risks
Screening finds breast cancers that would never have caused a woman harm.
Most women who receive an abnormal screening result are found not to have breast cancer on further testing. These women may experience worry and feel distress until they are confirmed not to have cancer.
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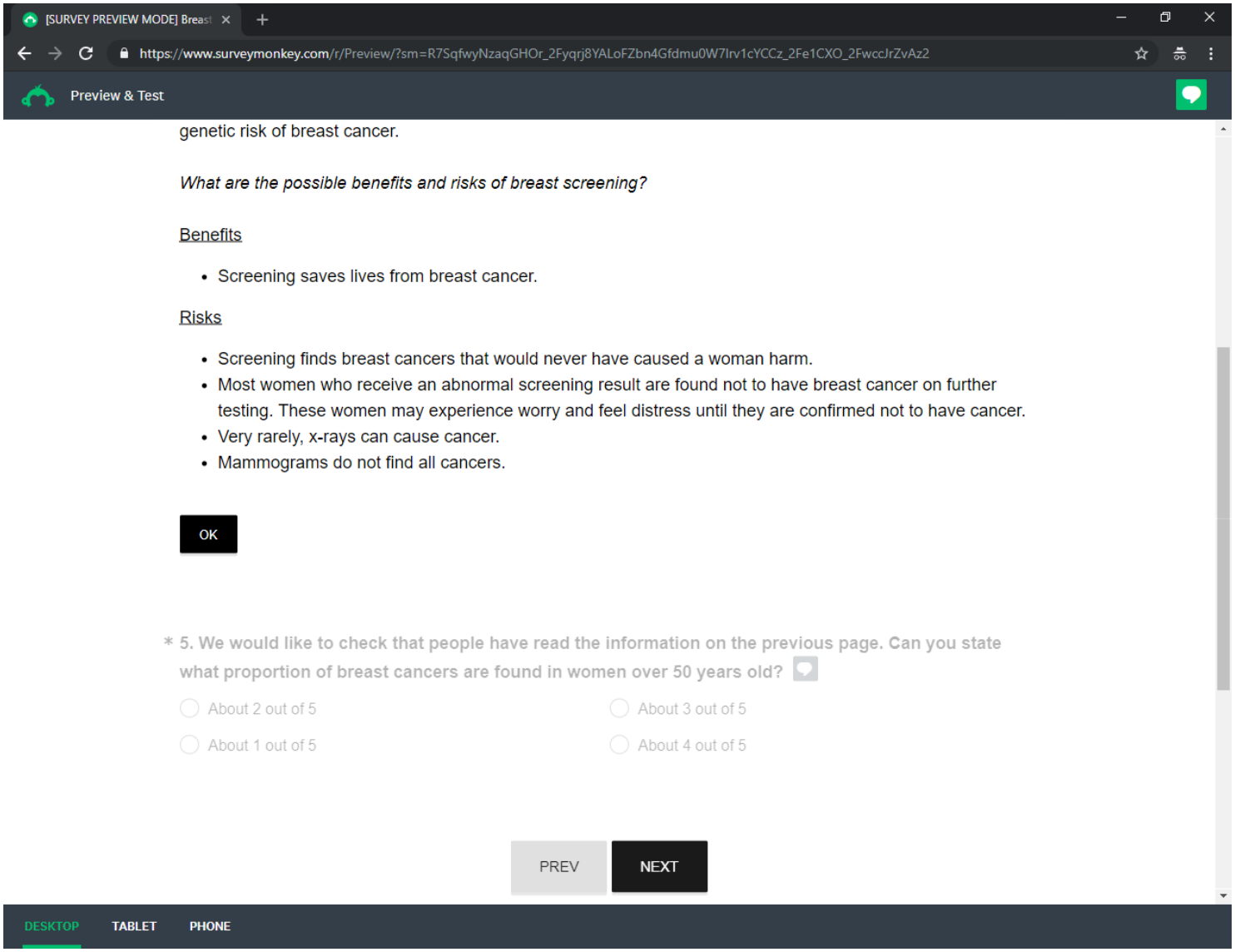
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Preview & Test
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Risks
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Most women who receive an abnormal screening result are found not to have breast cancer on further testing. These women may experience worry and feel distress until they are confirmed not to have cancer.
Very rarely, x-rays can cause cancer.
Mammograms do not find all cancers.
OK
* 5. We would like to check that people have read the information on the previous page. Can you state what proportion of breast cancers are found in women over 50 years old?
About 2 out of 5
About 3 out of 5
About 1 out of 5
About 4 out of 5
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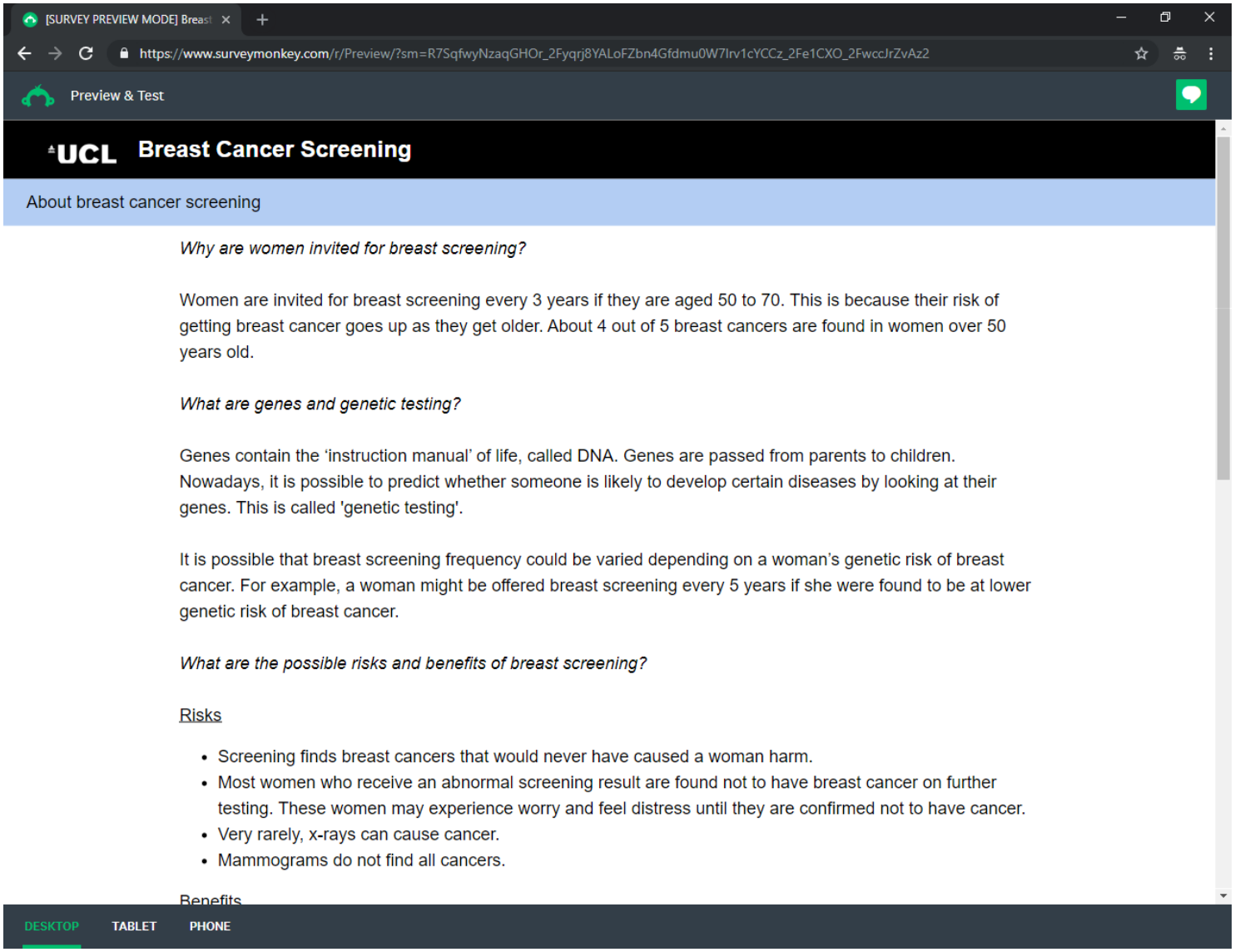
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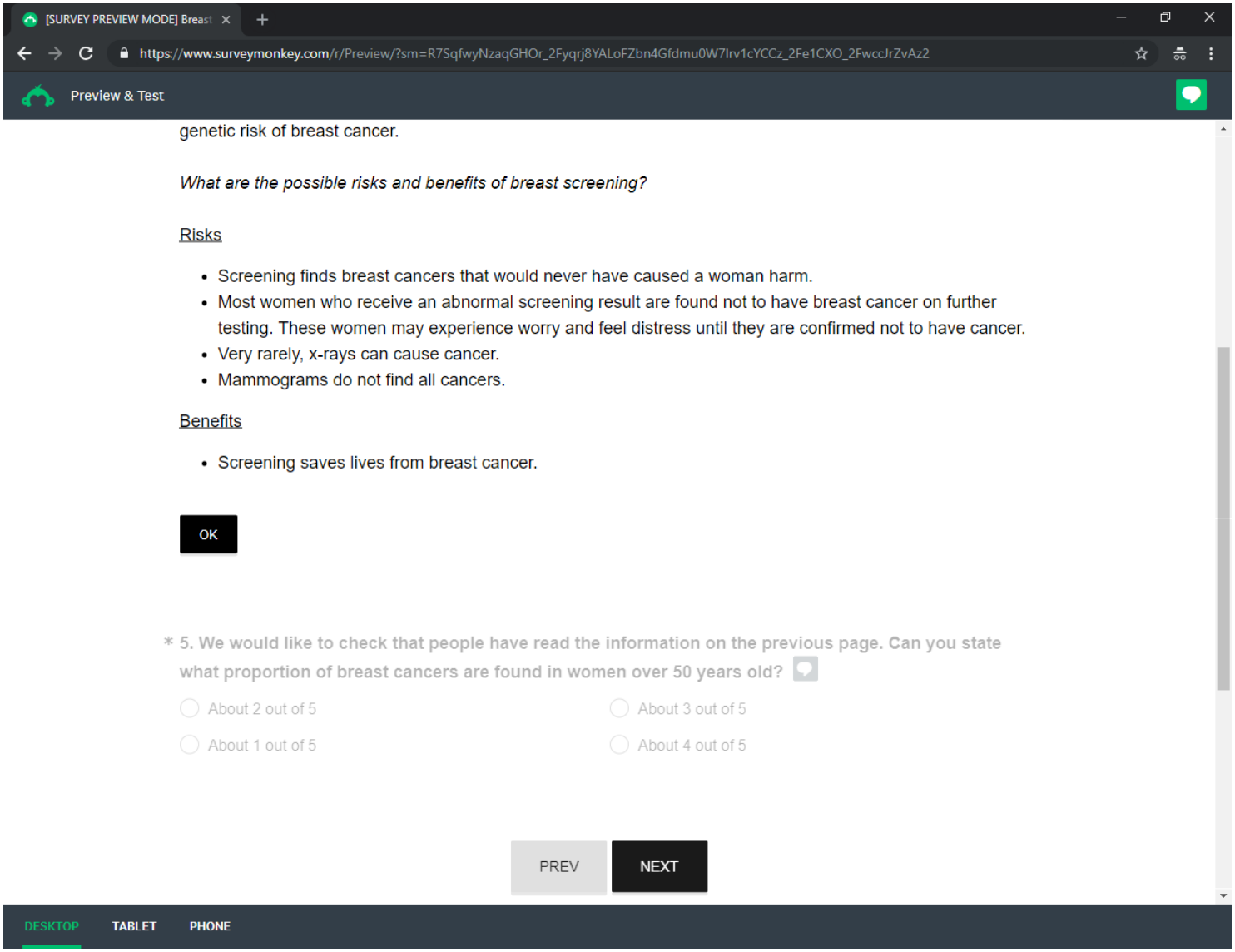
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Preview & Test
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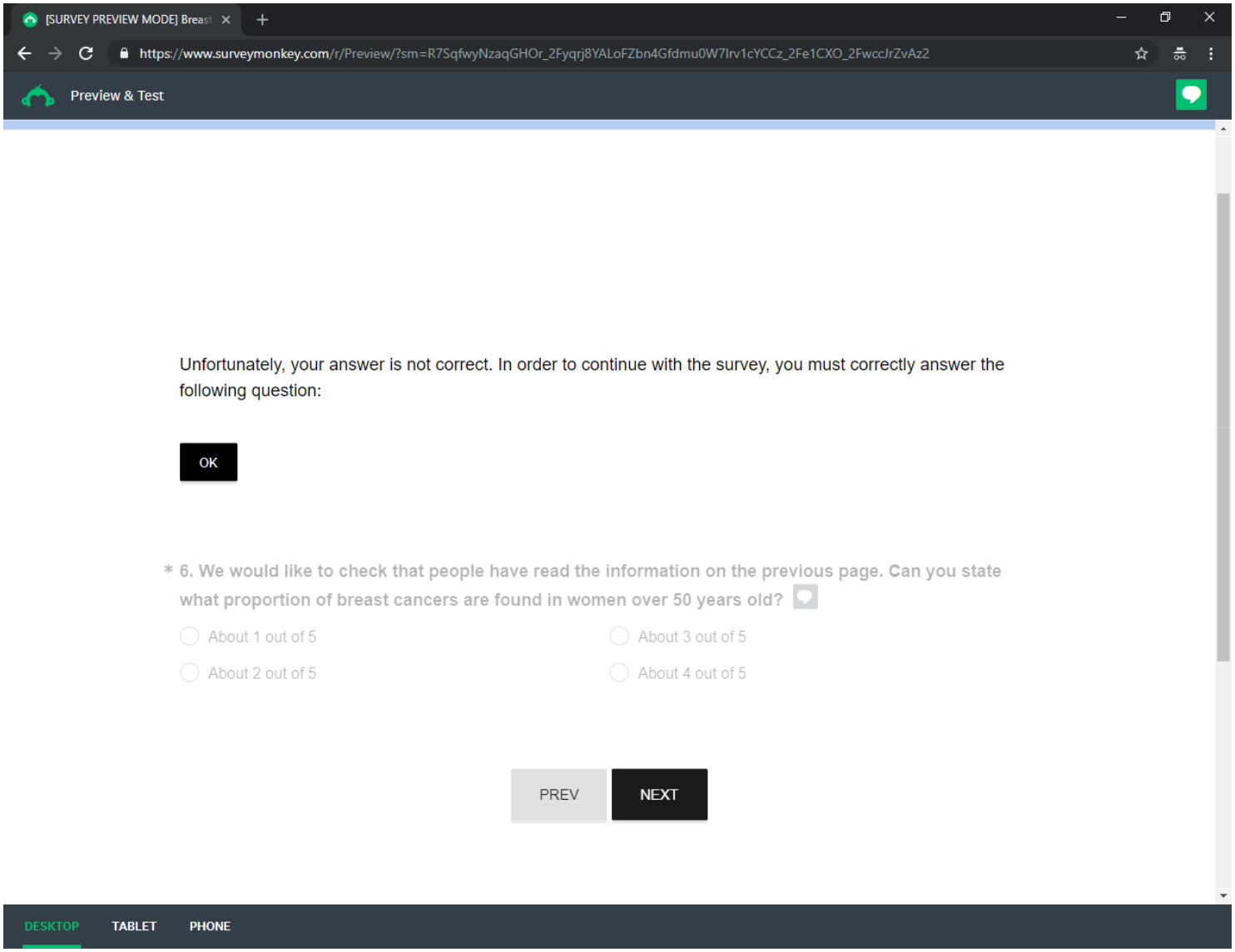
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Preview & Test
Unfortunately, your answer is not correct. In order to continue with the survey, you must correctly answer the following question:
OK
* 6. We would like to check that people have read the information on the previous page. Can you state what proportion of breast cancers are found in women over 50 years old?
About 1 out of 5
About 3 out of 5
About 2 out of 5
About 4 out of 5
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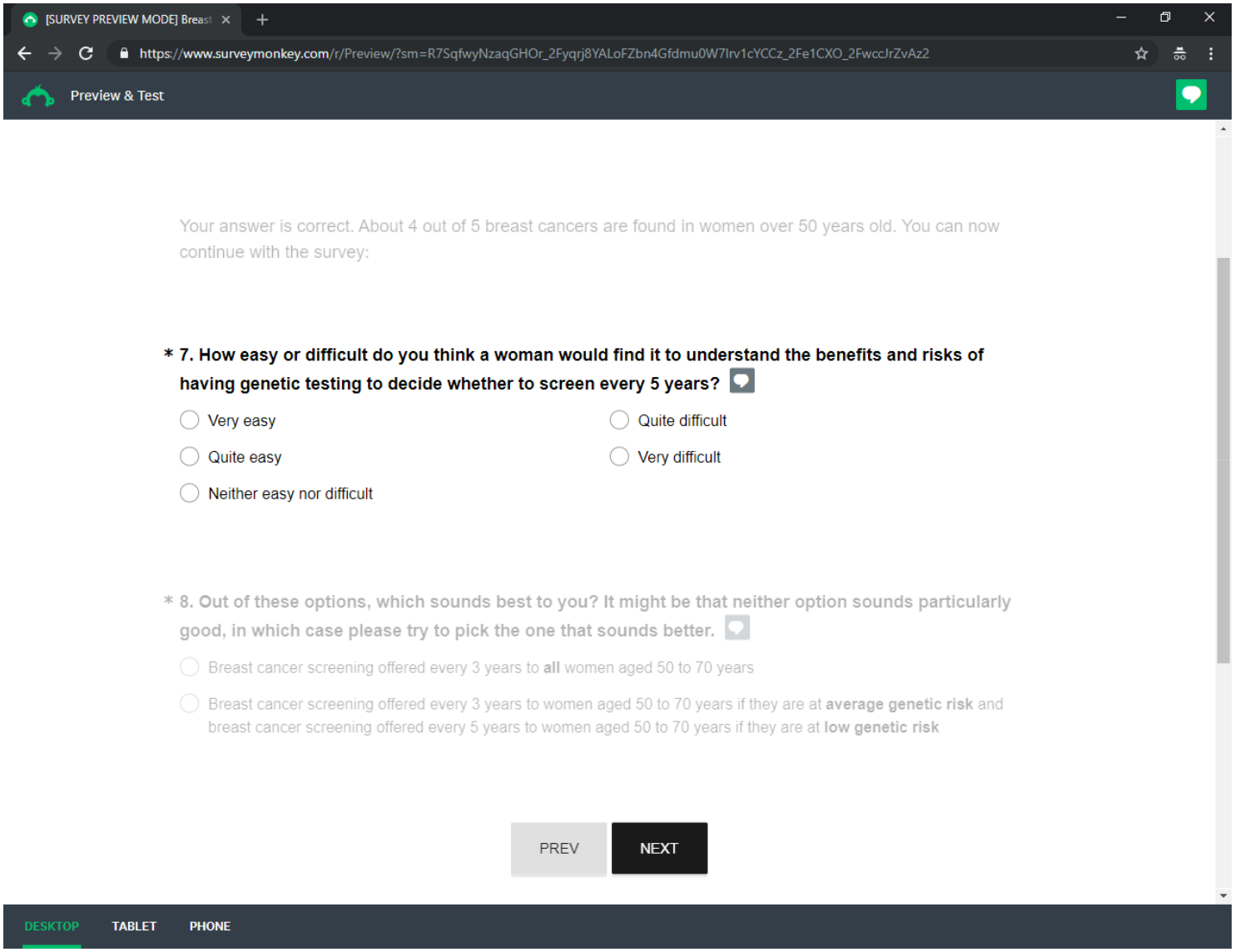
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Preview & Test
Your answer is correct. About 4 out of 5 breast cancers are found in women over 50 years old. You can now continue with the survey:
* 7. How easy or difficult do you think a woman would find it to understand the benefits and risks of having genetic testing to decide whether to screen every 5 years?
Very easy
Quite easy
Neither easy nor difficult
Quite difficult
Very difficult
* 8. Out of these options, which sounds best to you? It might be that neither option sounds particularly good, in which case please try to pick the one that sounds better.
Breast cancer screening offered every 3 years to all women aged 50 to 70 years
Breast cancer screening offered every 3 years to women aged 50 to 70 years if they are at average genetic risk and breast cancer screening offered every 5 years to women aged 50 to 70 years if they are at low genetic risk
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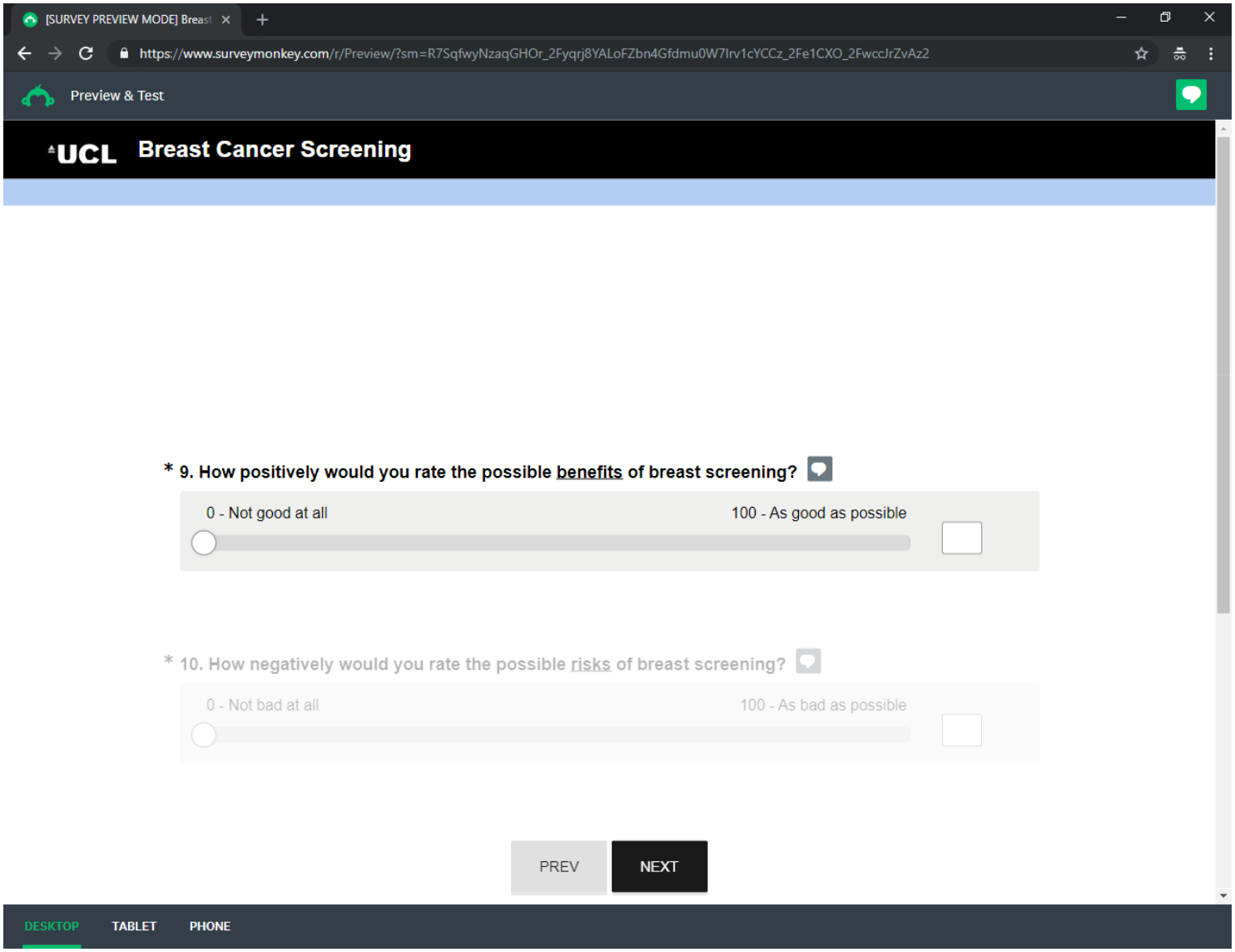
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Preview & Test
UCL Breast Cancer Screening
* 9. How positively would you rate the possible benefits of breast screening?
0 - Not good at all
100 - As good as possible
* 10. How negatively would you rate the possible risks of breast screening?
0 - Not bad at all
100 - As bad as possible
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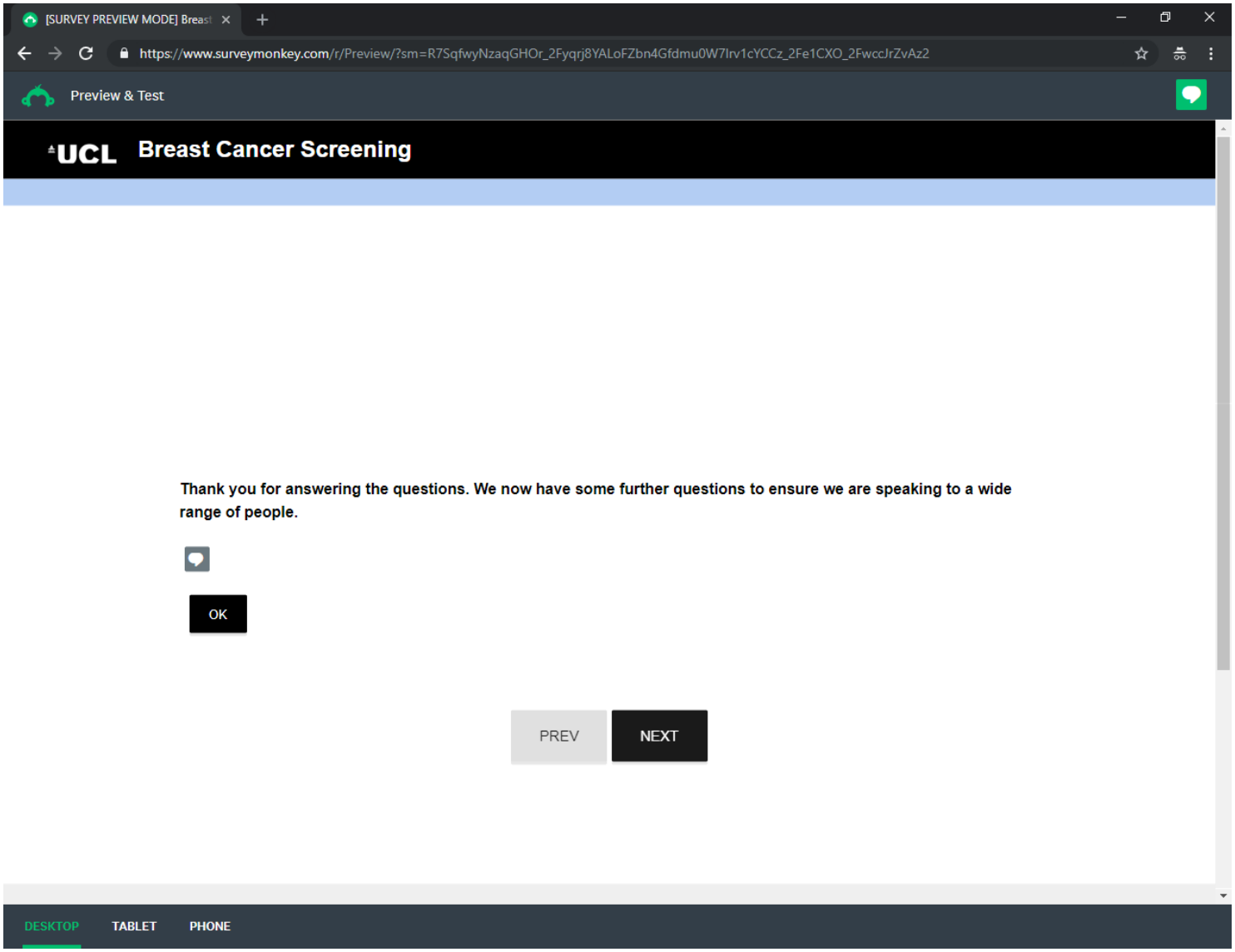
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Preview & Test
UCL
Breast Cancer Screening
Thank you for answering the questions. We now have some further questions to ensure we are speaking to a wide range of people.
OK
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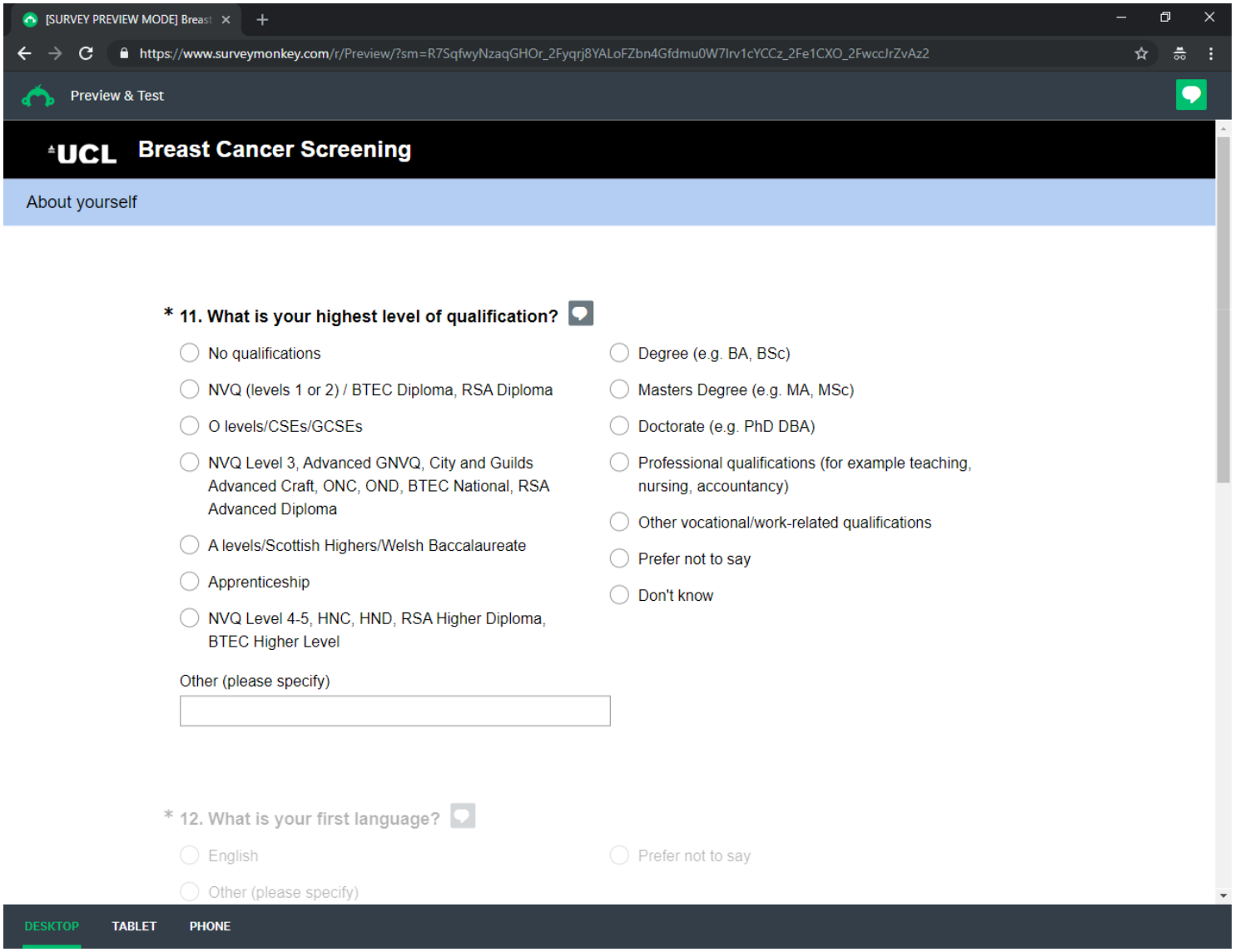
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Preview & Test
UCL Breast Cancer Screening
About yourself
* 11. What is your highest level of qualification?
No qualifications
NVQ (levels 1 or 2) / BTEC Diploma, RSA Diploma
O levels/CSEs/GCSEs
NVQ Level 3, Advanced GNVQ, City and Guilds Advanced Craft, ONC, OND, BTEC National, RSA Advanced Diploma
A levels/Scottish Highers/Welsh Baccalaureate
Apprenticeship
NVQ Level 4-5, HNC, HND, RSA Higher Diploma, BTEC Higher Level
Degree (e.g. BA, BSc)
Masters Degree (e.g. MA, MSc)
Doctorate (e.g. PhD DBA)
Professional qualifications (for example teaching, nursing, accountancy)
Other vocational/work-related qualifications
Prefer not to say
Don't know
Other (please specify)
* 12. What is your first language?
English
Prefer not to say
Other (please specify)
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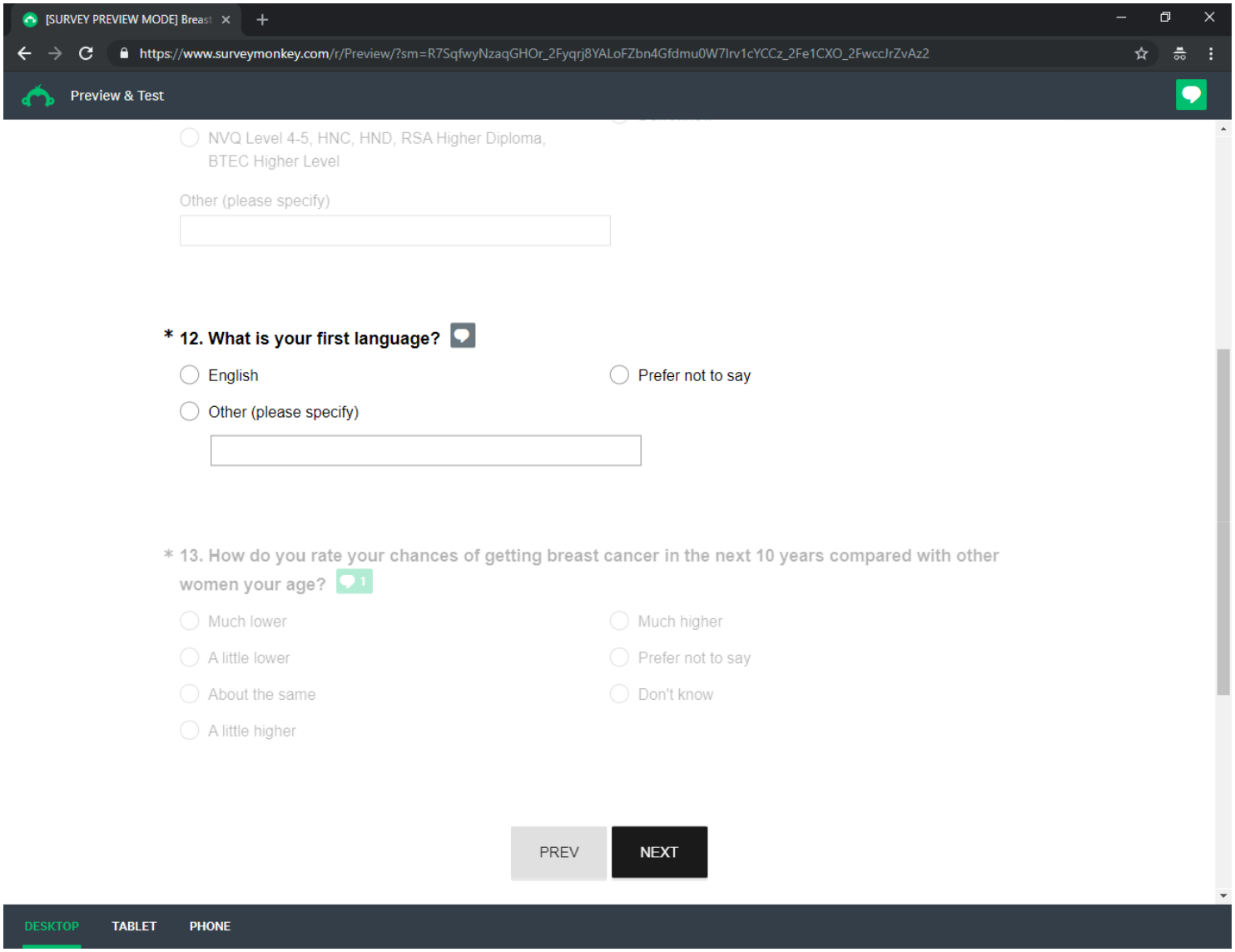
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Preview & Test
NVQ Level 4-5, HNC, HND, RSA Higher Diploma, BTEC Higher Level
Other (please specify)
* 12. What is your first language?
English
Prefer not to say
Other (please specify)
* 13. How do you rate your chances of getting breast cancer in the next 10 years compared with other women your age?
Much lower
Much higher
A little lower
Prefer not to say
About the same
Don't know
A little higher
PREV
NEXT
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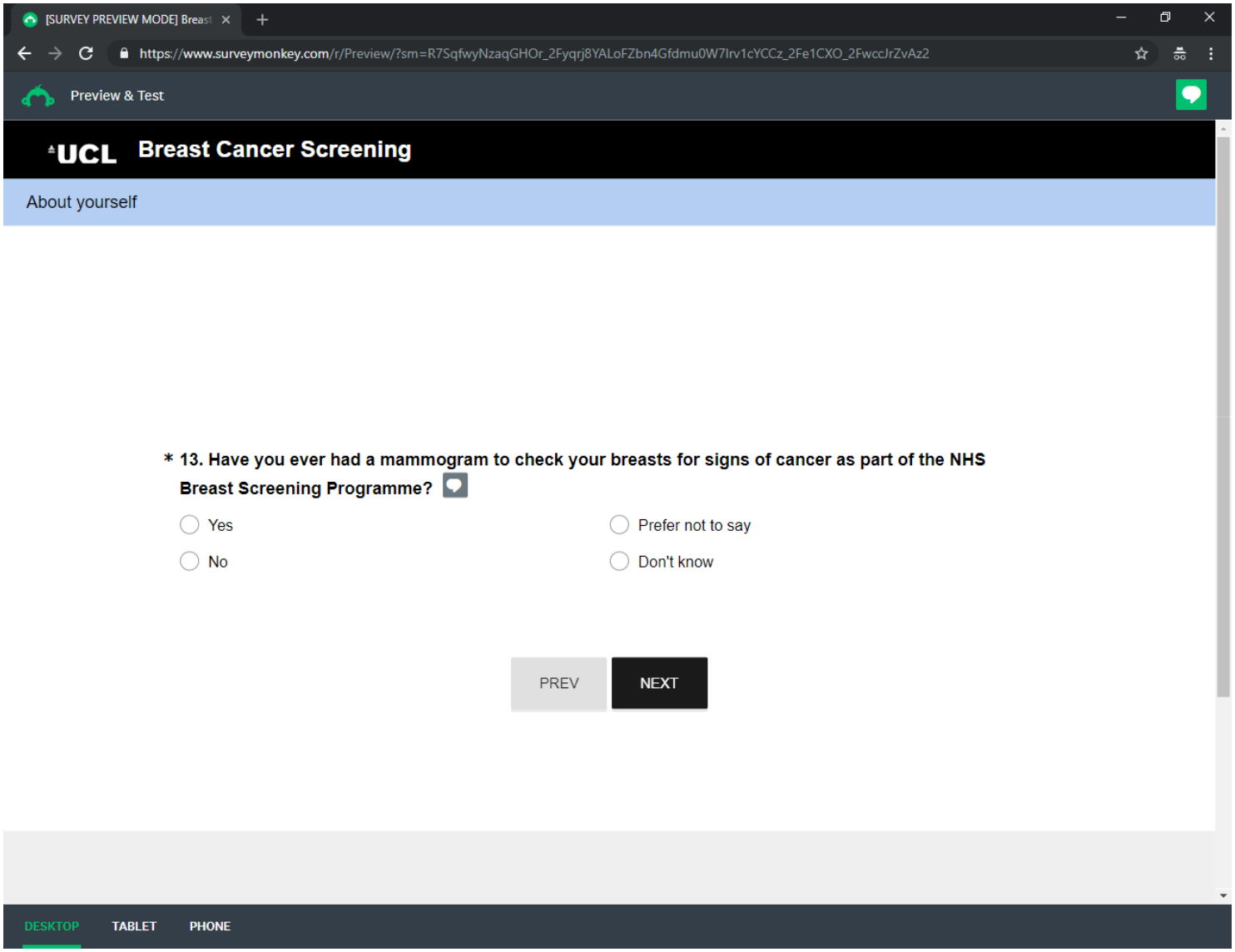
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Preview & Test
UCL Breast Cancer Screening
About yourself
* 13. Have you ever had a mammogram to check your breasts for signs of cancer as part of the NHS Breast Screening Programme?
Yes
No
Prefer not to say
Don't know
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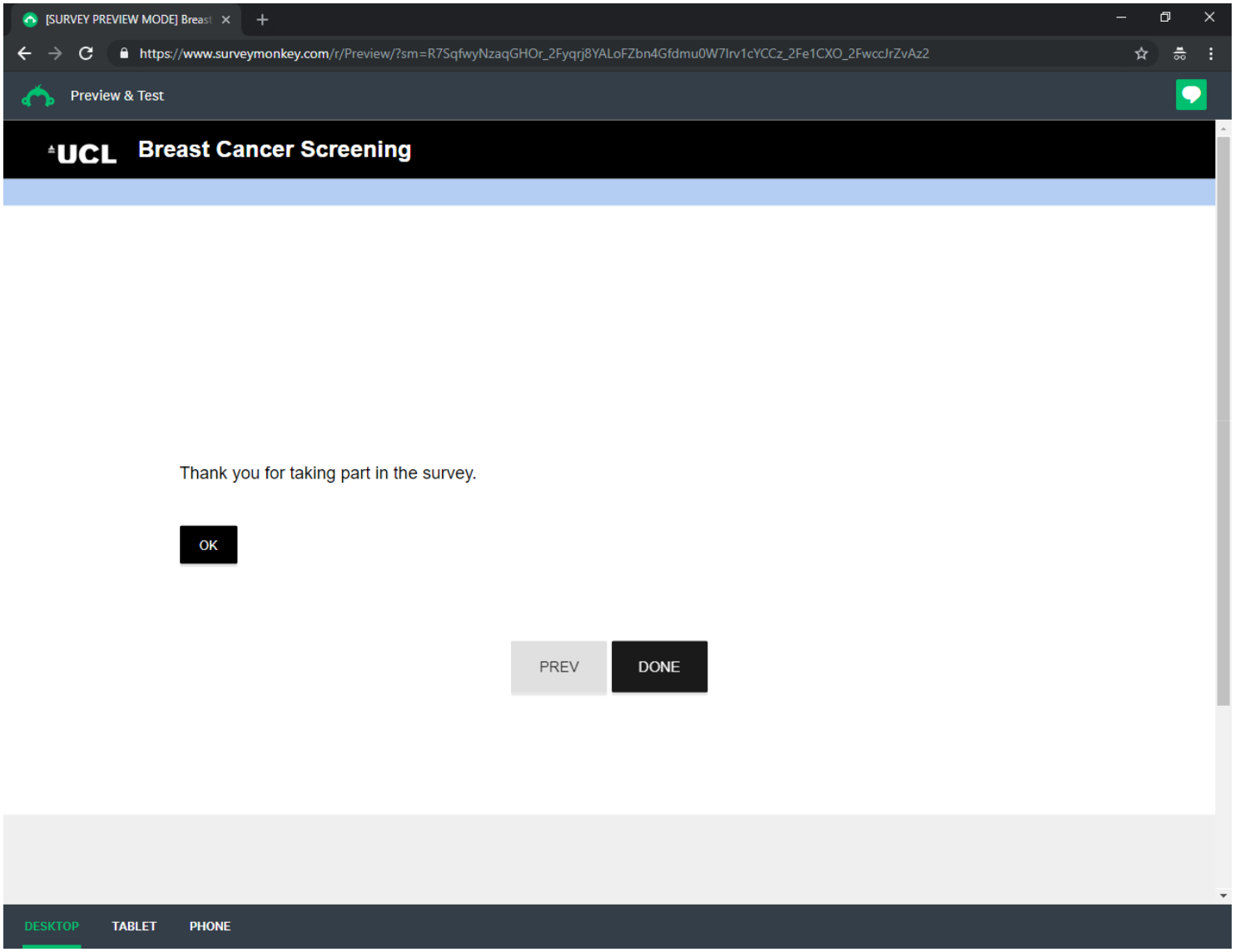
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Preview & Test
UCL
Breast Cancer Screening
Thank you for taking part in the survey.
OK
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DONE
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